

WHAT IS CLAIMED IS:

1. An in-shell egg pasteurization system configured to pasteurize and handle eggs comprising:
  - a loading system configured to accept an in-shell egg; and
  - a microwave system configured to impart microwave energy to a yolk of the in-shell egg in accordance with at least one of a size and a temperature of the yolk to heat the yolk to a first predetermined temperature and to impart microwave energy to an albumen of the in-shell egg to heat the albumen to a second predetermined temperature.
2. The system according to claim 1, further comprising a packer configured to pack the in-shell egg, the packer arranged one of downstream and upstream of the microwave system.
3. The system according to claim 1, further comprising a high-speed grading system configured to grade the in-shell egg, the grading system arranged one of downstream and upstream of the microwave system.
4. The system according to claim 1, further comprising an egg washer configured to wash an exterior of the in-shell egg.
5. The system according to claim 4, further comprising an egg dryer configured to dry the in-shell egg.
6. The system according to claim 1, further comprising a leak detector and removal system configured to identify and remove the in-shell eggs having a leak.
7. The system according to claim 1, further comprising a crack detector and removal system configured to identify and remove the in-shell egg having a crack.

8. The system according to claim 1, further comprising a dirt detector and removal system configured to identify and remove an in-shell egg having dirt on a surface.

9. The system according to claim 1, further comprising a weighing and removal system configured to determine a weight of the in-shell egg.

10. The system according to claim 9, wherein the weighing and removal system is configured to remove the in-shell egg in accordance with at least one of the weight and a starting temperature.

11. The system according to claim 9, wherein the microwave system is configured to impart the microwave energy to at least one of the yolk and the albumen in accordance with the weight.

12. The system according to claim 1, further comprising an oven configured to maintain the in-shell egg at a predetermined pasteurization temperature for a predetermined time interval arranged downstream of the microwave system.

13. The system according to claim 12, wherein the predetermined pasteurization temperature is in a range of between 120°F and 140°F.

14. The system according to claim 12, wherein the predetermined time interval is between 10 minutes and 90 minutes.

15. The system according to claim 12, wherein the oven includes a heating medium.

16. The system according to claim 15, wherein the heating medium includes at least one of hot air and steam.

17. The system according to claim 1, further comprising a cooler configured to cool the in-shell egg.

18. The system according to claim 17, wherein the cooler is configured to cool the in-shell egg to a temperature in a range of between 45°F and 75°F.

19. The system according to claim 1, further comprising an equilibrator arranged upstream of the microwave system, the equilibrator configured to heat the in-shell egg to a third predetermined temperature.

20. The system according to claim 19, wherein the third predetermined temperature is in a range of between 100°F and 130°F.

21. The system according to claim 1, wherein the first predetermined temperature is in a range of between 130°F and 160°F.

22. The system according to claim 1, wherein the second predetermined temperature is in a range of between 100°F and 140°F.

23. An in-shell egg pasteurization system to pasteurize and handle graded eggs, comprising:

a loading system configured to accept an in-shell egg;  
a grading system configured to grade the in-shell egg;  
and

a microwave system configured to impart microwave energy to a yolk of the in-shell egg in accordance with at least one of a size and a temperature of the yolk to heat the yolk to a first predetermined temperature and to impart microwave energy to an albumen of the in-shell egg heat the albumen to a second predetermined temperature.

24. The system according to claim 23, further comprising a packer configured to pack the in-shell egg, the packer arranged downstream of the microwave system.

25. The system according to claim 23, further comprising a packer configured to pack the in-shell egg, the microwave system arranged between the packer and the grading system.

26. The system according to claim 23, further comprising an egg washer configured to wash an exterior of the in-shell egg.

27. The system according to claim 26, further comprising an egg dryer configured to dry the in-shell egg.

28. The system according to claim 23, further comprising a leak detector and removal system configured to detect the in-shell egg having a leak.

29. The system according to claim 23, further comprising an oven configured to maintain the in-shell egg at a predetermined pasteurization temperature for a predetermined time interval arranged downstream of the microwave system.

30. The system according to claim 29, wherein the predetermined pasteurization temperature is in a range of between 120°F and 140°F.

31. The system according to claim 29, wherein the predetermined time interval is in a range of between 10 minutes and 90 minutes.

32. The system according to claim 29, wherein the oven includes a heating medium.

33. The system according to claim 32, wherein the heating medium includes at least one of hot air and steam.

34. The system according to claim 23, further comprising a cooler configured to cool the in-shell egg.

35. The system according to claim 34, wherein the cooler is configured to cool the in-shell egg to a temperature in a range of between 45°F and 75°F.

36. The system according to claim 23, further comprising an equilibrator arranged upstream of the microwave system, the equilibrator configured to heat the in-shell egg to a third predetermined temperature.

37. The system according to claim 36, wherein the third predetermined temperature is in a range of between 100°F and 130°F.

38. A method for pasteurizing an in-shell egg, comprising the steps of:

determining at least one of a weight and a temperature of a yolk of the in-shell egg;

microwaving the yolk in accordance with the one of the weight and the temperature determined in the determining step to heat the yolk to a first predetermined temperature;

microwaving the albumen to heat the albumen to a second predetermined temperature.

39. The method according to claim 38, further comprising the step of maintaining the in-shell egg at a predetermined pasteurization temperature for a predetermined time interval after the microwaving steps.

40. The method according to claim 39, wherein the predetermined pasteurization temperature is in a range of between 120°F and 140°F.

41. The method according to claim 39, wherein the predetermined time interval is in a range of between 10 minutes and 90 minutes.

42. The method according to claim 38, further comprising the step of cooling the in-shell egg after the microwaving steps.

43. The method according to claim 42, wherein the in-shell egg is cooled to a temperature in a range of between 45°F and 75°F in the cooling step.

44. The method according to claim 38, wherein the first predetermined temperature is in a range of between 130°F and 160°F.

45. The method according to claim 38, wherein the second predetermined temperature is in a range of between 100°F and 140°F.

46. The method according to claim 38, further comprising the step of heating the in-shell egg to a third predetermined temperature before the microwaving steps.

47. The method according to claim 46, wherein the third predetermined temperature is in a range of between 100°F and 130°F.

48. The method according to claim 46, wherein the in-shell egg is heated in the heating step using a heating medium.

49. The method according to claim 48, wherein the heating medium includes at least one of hot air and steam.

50. An in-shell egg pasteurization system, comprising an oven configured to increase a temperature of an in-shell egg

to a first predetermined temperature in a range of between 120°F and 140°F for a predetermined time interval.

51. The system according to claim 50, further comprising a cooler arranged downstream of the oven and configured to reduce the temperature of the in-shell egg to a second predetermined temperature in a range of between 45°F and 75°F.

52. The system according to claim 50, wherein the predetermined time interval is between 10 minutes and 120 minutes.

53. The system according to claim 50, wherein the oven includes a heating medium.

54. The system according to claim 53, wherein the heating medium includes at least one of hot air and steam.

55. The system according to claim 51, wherein the cooler is configured to cool the in-shell egg for a time interval in a range of between 1 minute and 20 minutes.

56. The system according to claim 49, further comprising:

a packer configured to pack the in-shell egg; and  
a grader configured to grade the in-shell egg;  
wherein the oven is arranged between the packer and the grader.

57. A method of pasteurizing an in-shell egg, comprising the steps of:

heating the in-shell egg to a first predetermined temperature in a range of between 120°F and 140°F for a predetermined time interval; and

cooling the in-shell egg to a second predetermined temperature in a range of between 45°F and 75°F after the heating step.

58. The method according to claim 57, wherein the predetermined time interval is in a range of between 10 minutes and 120 minutes.

59. The method according to claim 57, wherein the in-shell egg is heated in the heating step with a heating medium.

60. The method according to claim 59, wherein the heating medium includes at least one of hot air and steam.

61. The method according to claim 57, wherein the in-shell egg is cooled in the cooling step for a predetermined time interval between 1 minute and 20 minutes.

62. An in-shell egg pasteurization system, comprising:  
a microwave system configured to impart microwave energy to a yolk of the in-shell egg in accordance with at least one of a size and a temperature of the yolk to heat the yolk to a first predetermined temperature and to impart microwave energy to an albumen of the in-shell egg to heat the albumen to a second predetermined temperature.

63. The system according to claim 62, wherein the first predetermined temperature is in a range of between 130°F and 160°F.

64. The system according to claim 62, wherein the second predetermined temperature is in a range of between 100°F and 140°F.

65. The system according to claim 62, further comprising an equilibrator arranged upstream of the microwave system, the equilibrator configured to heat the in-shell egg to a third predetermined temperature.

66. The system according to claim 65, wherein the third predetermined temperature is in a range of between 100°F and 130°F.

67. The system according to claim 62, further comprising an oven arranged downstream of the microwave system, the oven configured to maintain the in-shell egg at a predetermined pasteurization temperature for a predetermined time interval.

68. The system according to claim 67, wherein the predetermined pasteurization temperature is in a range of between 120°F and 140°F.

69. The system according to claim 67, wherein the predetermined time interval is in a range of between 10 minutes and 90 minutes.

70. The system according to claim 62, further comprising a cooler arranged downstream of the microwave system, the cooler configured to cool the in-shell egg to a third predetermined temperature.

71. The system according to claim 70, wherein the third predetermined temperature is in a range of between 45°F and 75°F.

72. The system according to claim 70, wherein the cooler is configured to cool the in-shell egg for a predetermined time interval.

73. The system according to claim 72, wherein the predetermined time interval is in a range of between 1 minute and 20 minutes.

74. A method of pasteurizing an in-shell egg, comprising the steps of:

microwaving a yolk of the in-shell egg in accordance with at least one of a size and a temperature of the yolk to heat the yolk to a first predetermined temperature; and

microwaving an albumen of the in-shell egg to heat the albumen to a second predetermined temperature.

75. The method according to claim 74, wherein the first predetermined temperature is in a range of between 130°F and 160°F.

76. The method according to claim 74, wherein the second predetermined temperature is in a range of between 100°F and 140°F.

77. The method according to claim 74, further comprising the step of heating the in-shell egg to a third predetermined temperature before the microwaving steps.

78. The method according to claim 77, wherein the third predetermined temperature is in a range of between 100°F and 130°F.

79. The method according to claim 74, further comprising the step of maintaining the in-shell egg at a predetermined pasteurization temperature for a predetermined time interval after the microwaving steps.

80. The method according to claim 79, wherein the predetermined pasteurization temperature is in a range of between 120°F and 140°F.

81. The method according to claim 79, wherein the predetermined time interval is in a range of between 10 minutes and 90 minutes.

82. The method according to claim 74, further comprising the step of cooling the in-shell egg to a third predetermined temperature after the microwaving steps.

83. The method according to claim 82, wherein the third predetermined temperature is in a range of between 45°F and 75°F.

84. The method according to claim 82, wherein the in-shell egg is cooled in the cooling step for a predetermined time interval.

85. The method according to claim 84, wherein the predetermined time interval is in a range of between 1 minute and 20 minutes.